NASA SP-7008

Preparing Contractor Reports for NASA

Technical Illustrating

JULY 1964

SCIENTIFIC AND TECHNICAL INFORMATION DIVISION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON, D. C.

FOREWORD

This booklet has been prepared in response to numerous requests from NASA grantees and contractors who do not have the services of large and experienced publications staffs. It offers guidance on how to prepare required technical reports so that NASA may, if it desires, reprint them for further distribution. The suggestions offered here are not intended to supplant other acceptable practices. Specific questions on publications problems and techniques, as well as requests for additional copies of this guide, may be addressed to Code ATSP-S, National Aeronautics and Space Administration, Washington, D. C. 20546.

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Introduction . . .

Illustrations, like illustrators, come in all sizes, shapes, and styles. The purpose of this booklet is to help you select the size, shape, and style of illustrations for use in NASA-printed technical publications.

NASA prints technical publications from your originals, using the photo-offset process. No diazo or intermediate-master copies are ordinarily reproduced. This lightens your burden because you may prepare illustrations using short-cuts like paste-ups, stick-up type, and cold-type composition (typewriter, Headliner, Varityper) and make oversize drawings for reduction. We won't even mention that you can cover mistakes with chinese white instead of erasing.

(Tear this page out for the new man. When he has learned it, give him the rest of the book.)

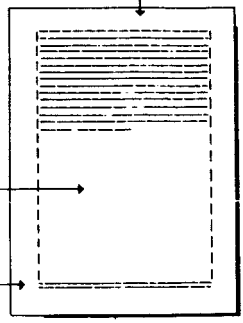
Publications Primer . . .

The typist types the text directly on the layout sheet.

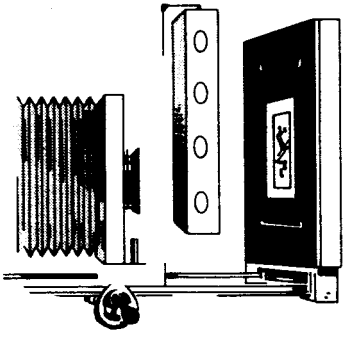
. . . leaving blank space for illustrations.

(You tell her how much space to leave)

The typist puts the caption here



You make the drawings and paste 'em in place (if they'll fit.) If they don't fit--scale 'em in--let the printer reduce to the correct size and position them on the pages.



The NASA printer photographs the copy and prints scads of reports.

P.S. If you've thought of about 17 questions by now, ask the boss for the booklet.

P.S. No. 2 Welcome aboard! We have lots of fun here.

Materials . . .

Publications illustrators don't need many special materials--just the usual things found around most drafting rooms plus an item or two. Here is a typical list of the most-needed items:

Layout Pencils. These can be blue, since light blue does not reproduce well.

Paper. Tracing paper is OK for line drawings, but there is nothing wrong with using any good grade of white paper.

Specialized Guides and Templates. Just so you don't spend a whole day plotting a few ellipses or electronic symbols.

T-squares, Triangles, etc. You know how handy these are.

India Ink. Sorry, bub, but your stuff goes to camera, and camera and plate boys have a way of getting gray hair over pencil drawings. It seems that graphite reflects light and sometimes a line or even a whole section of a drawing is cancelled when a stray reflection gets to the camera. Besides, your drawings look a darn sight better in ink.

Inking Tools. You know--the usual run of ruling pens, compasses, etc. Perhaps you would like to add a technical fountain pen to your collection--great for use with templates.

Red Ball-point Pens. The camera thinks red is blacker than black, and these are good for ruling tables, gridlines, etc. And think how much India ink you save!

Chinese White and White Correction Fluid. Mistakes are made all around--but it's the illustrator who corrects them! Better be equipped.

Water-color Brushes. Nos. 0, 1, 2, and 3 are dandy with lamp-black or chinese white for those finishing touches and last-minute corrections.

Plastic Mending Tape. Wonderful for corrections--just stick on soft repro paper, seams, or patches and do your inking on the tape.

Rubber Cement and Thinner. Paste it up--don't draw it.

Lettering Set? Honestly--don't bother. Your typist can rap out most of what you need for labels, scales, etc., much quicker. Just paste up the typing and use the time you save for high-level thinking.

Beret and Smock. These are wonderful props when a display of temperament is called for.

Graphs . . .

The meat of many a technical report is in its graphs. Preparing scores of graphs for publication can be a back-breaking job without some advance skull work.

If the engineer or technical guy has put his plot on the proper flavor of graph paper and has not written all over the grid lines, try this fast dodge:

1. Ink the curve.
2. Cut out the pertinent portion of the graph and rubber-cement it to a clean white sheet.
3. Blue-pencil (lightly) the notes, scales, legends,* etc., needed to complete the graph.
4. Most important--let the typist finish the graph.

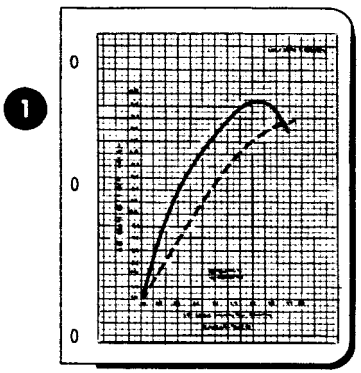
Remember:

Use red or orange-line graph paper, and the coarsest grid feasible.

The grid, when reproduced, will be black, black, black. Ink the curve and/or points heavily enough to show.

Don't erase--patch "take-outs" with a matching section of the same pattern.

*Explanatory lists of symbols. The proper title is carried along with figure number in the caption. Let the typist worry about all captions.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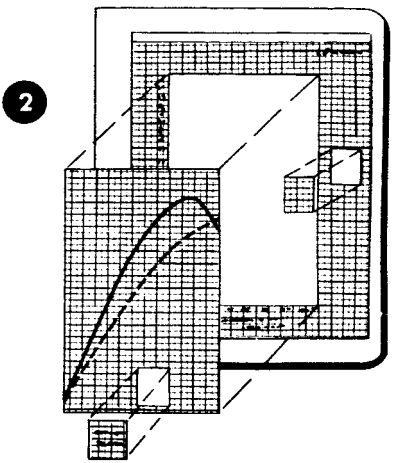
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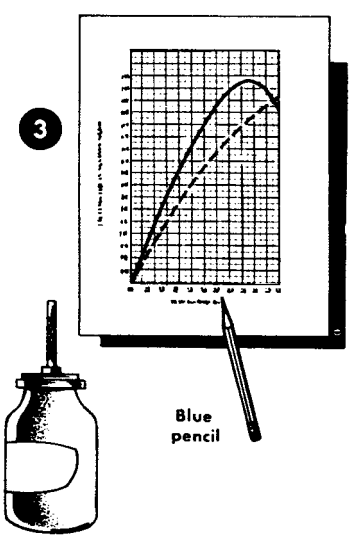
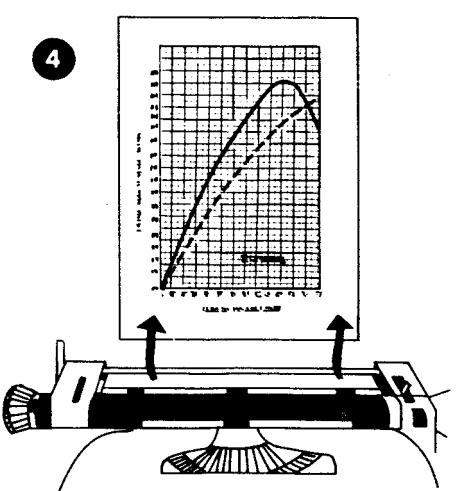

3
Blue
pencil

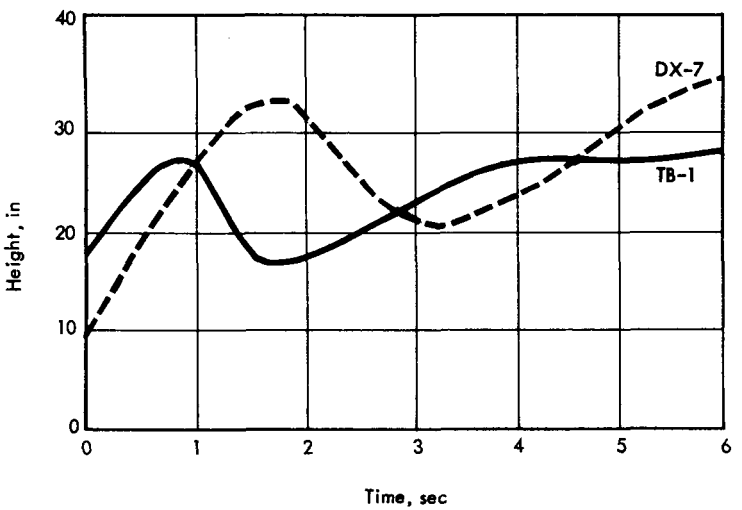

4

Of course, you don't have to use graph paper--very often the best-quality graphs are prepared by using ruled grids. When doing one that way, try these hints:

Don't plot it--trace the curve from the engineer's scratch plot.

Watch your line weights:

Frame - Medium
Grid - Fine
Curve - Heaviest



If you have a great many of these graphs--a family, so to say, all having the same scales and annotations--prepare one master complete except for the data. Have the printer reproduce the required number and plot each individual graph.

Reproductions may be made with photo-offset, blackline diazo, or any process yielding a first-class black image on white paper.

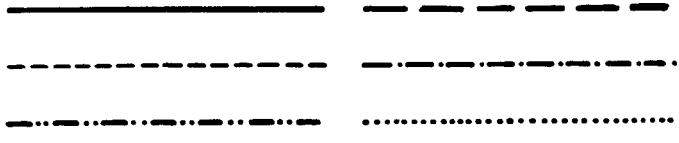
Most engineers, when plotting data on a graph, use distinctive data points and coded (or color) lines for curves. The engineer's problem ends with any legible arrangement he invents, but yours is just beginning. Your arrangements of distinctive data points, coded curves, etc., must first stand the rigors of printing, then communicate instantly to your reader.

- Use distinctive shapes for data points:

- Use filled and open shapes:

- Avoid subtle distinctions:

- Use bold line coding--go from simple to complex, but remember the reader's problem in following the curve:



- Bear in mind the effect of a finely divided, busy background grid. Simplify when possible.

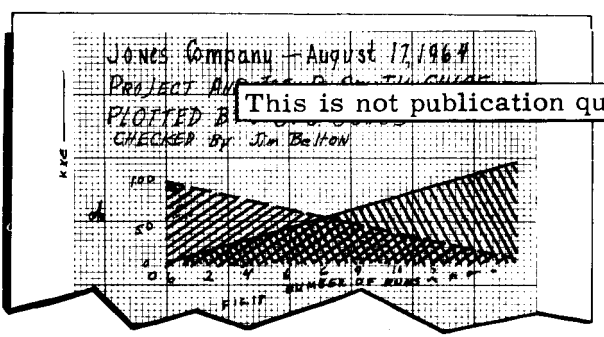
- Complex, over-plotted graphic data can usually be broken down into a series.

- Remember that printing often destroys subtleties--make it obvious!

You probably wouldn't hang a graph in an art museum, but who can deny that some graphs have a more sophisticated air than others. In fact, making a presentation easy to read also contributes to its beauty. As an illustrator, you make innumerable unconscious artistic decisions as you go about preparing any technical presentation.

By exercising your own good taste and judgement, you can do a great deal to both enhance and clarify your drawings. Here are some particular points to watch:

- "Hatching" or shading should not be too dense or prominent.
- Size of lettering should be compatible with graphic material; not overpowering, not too timid.
- Line weights should be varied to show relative importance.
- All figures, even graphs, should be composed, balanced, and have a pleasing appearance.



You don't need captions, titles, plotter's and checker's names, drawing numbers, dates, etc., on your graphs. Remember--the illustration and text are interdependent and each is essentially incomplete without the other. Necessary identification, description, sources, etc., are properly placed in the caption.

Line Drawings . . .

Line drawings, next to graphs, are the most popular form of graphics in scientific and technical reporting. Here is a real chance to shine, for these offer you the opportunity to help direct the reader's thinking.

Generally, you know that line drawings fall into three very broad categories:

- Recognition Views
- Construction Drawings
- Schematics

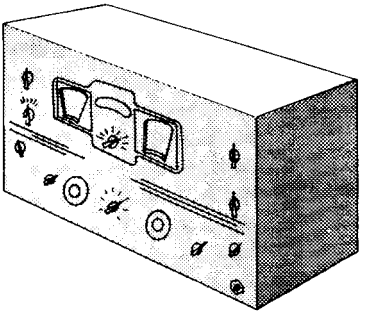
Put this knowledge to good use. When you receive a request for a drawing, ask these four questions:

- What is the purpose of the proposed drawing?
- What feature is to be shown?
- Do I have enough information?
- How can I separate the most important information from the rest?

From the answers to those questions, you can easily tell what kind of drawing is needed. Then the fun begins.

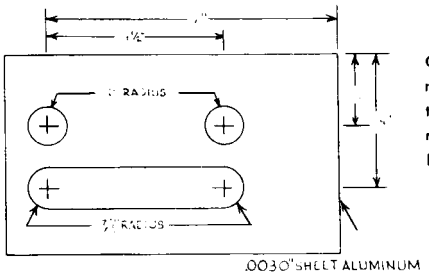
Recognition Views. These are usually very general, and should explain as much as possible about the subject's nature, size, and physical characteristics. Ordinarily, a photograph fills the bill nicely and should be used where feasible. Line drawings are indispensable whenever nonexistent equipment, cramped interior views, or other difficult situations must be shown.

Recognition view



Characteristics: Emphasis on external features and appearance.
Wide audience appeal.

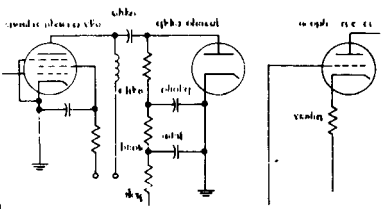
Construction drawing



Characteristics: Emphasis on how-to-make; frequently does not show how the item appears. Appeal is to subject-matter specialists or constructors. Rarely used in technical reports.

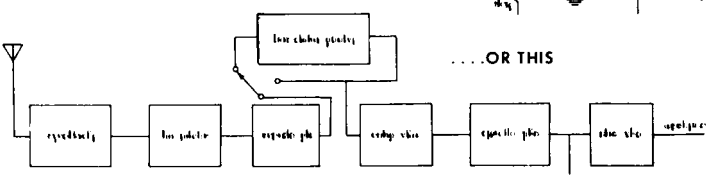
Schematic

THIS. . . .



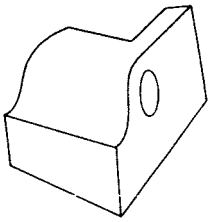
Characteristics: Emphasis on how-it-works; appearance and construction details are always lacking. Appeal is to scientists, subject-matter specialists. Commonly used in technical reports.

. . . .OR THIS

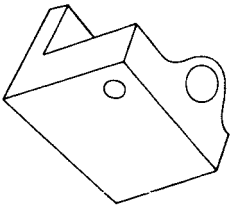


Everyone (even an engineer) understands appearance better from a "natural" view than from 3-view drawings. A good rule of thumb to follow is: show an item from the single most explanatory view.

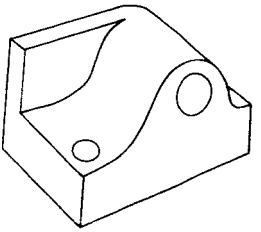
Judge for yourself from the illustration.



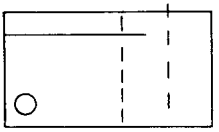
Poor

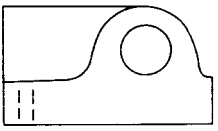


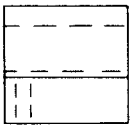
Poor



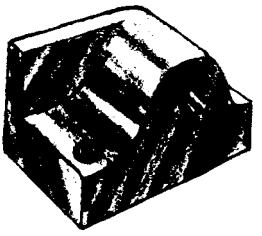
Better







Poor



Too much technique

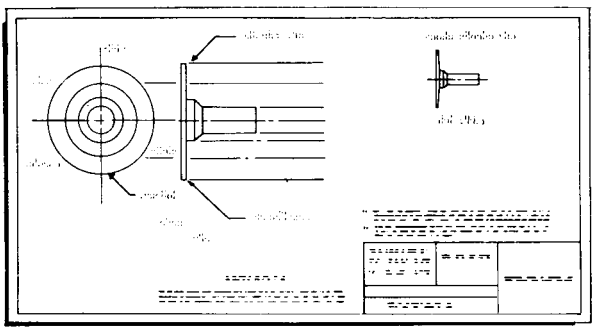
The drawing itself should be simple, with no undue emphasis on technique or rendering. The principal point to remember is: what does this say to my reader?

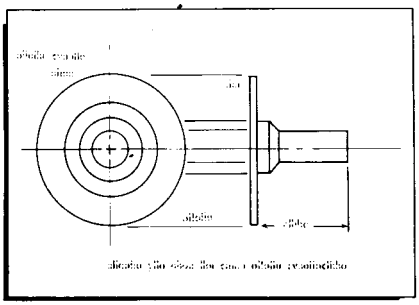
Construction Drawings. You will seldom find these specified in a research report; but when they are, try these suggestions:

- If you use reproductions of actual construction drawings, be sure the net result is legible, reproducible, and of the proper size.

- Many drawings will be composed of elements or views spread out widely on a large sheet. Very often you can move these closer together to make a more compact and legible drawing.

Original drawing





Modified for publication

- Always remove borders, title blocks, etc. Such information properly belongs in the caption.

- If the handlettering looks awful, replace it with typewriter copy or other clean lettering.

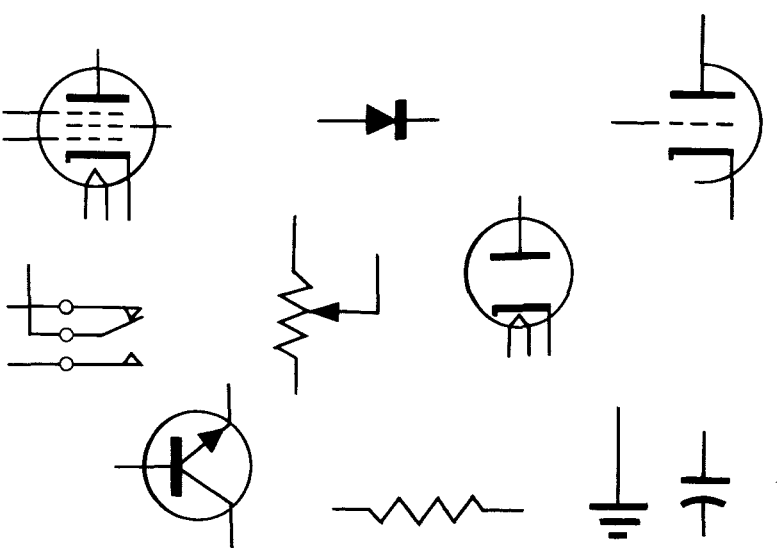
Schematic Drawings. A wide variety of these, from logic diagrams to plumbing layouts is used in technical literature. Your work will be lighter and your drawings more useful if you check some of these sweat-savers:

- Get the PROPER symbols. Refer to standard publications used by your engineers and scientists to learn the symbol, what it means, and how to draw it.

- Use short-cuts. Most standard symbols are available in stick-up type sheets. Let your typist be your lettering artist. Use the time you save to organize bigger and better schematics.

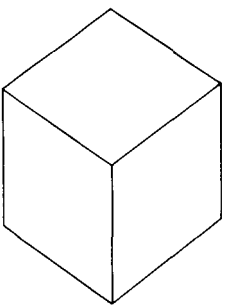
Use caps and lower-case lettering and expressions that are parallel to the text. Capital and lower-case letters and symbols often have different meanings. Avoid confusion--the reader has to shift gears mentally if presented with something like

transmitter, ... crystal ... x . . . Cos D . . . in the text
and
XMTR, . . . XTAL . . . X . . . COS D . . . in the illustration



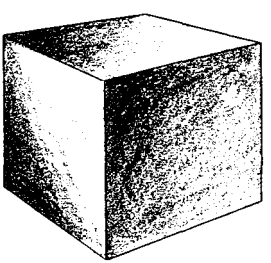
Perspective Drawings . . .

If you live in an isometric world where optical illusions are fairly common you'll think very little of seeing something like this:



Cube-
inside or outside view?

But your poor reader is often far removed from that world and is more accustomed to the "Madison Avenue" approach:

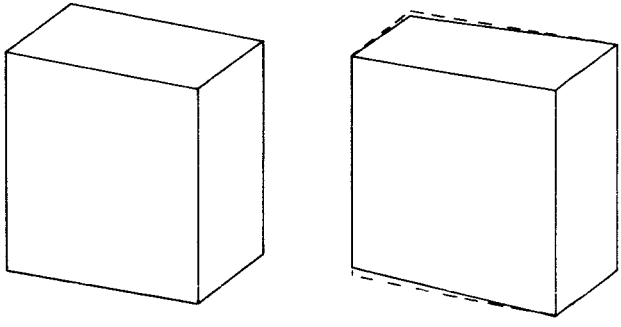


Cube-
no doubt about it!

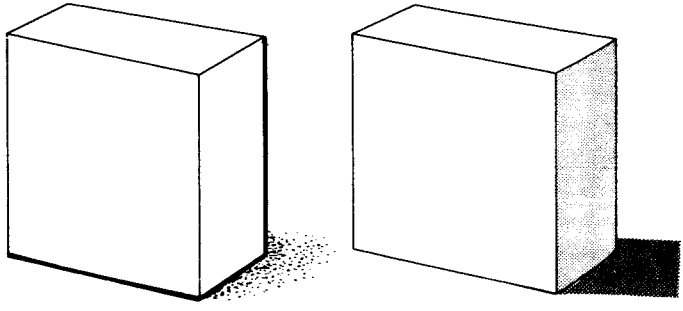
There is neither time nor necessity for making an ad agency job of every technical report; but some of the ad guys' ideas will make the average technical report better understood and perhaps a bit less forbidding looking. Here are some suggestions:

- It's not necessary to airbrush each line recognition drawing. Heavier lines to indicate outlines and shadows help greatly.

• Even faked perspective will help some 3-dimensional drawings. Always be careful to make any faked perspective very slight--just enough to overcome the typical optical illusion seen in isometric drawings.



• Shading one side of a drawing sometimes works wonders. Always use a shading sheet composed of halftone dots, rather than the "gray" type. Pencil shading usually reproduces rather poorly.



• Three-dimensional statistical presentations should always be handled as isometrics, rather than in perspective. The reason is that someone will always try to calibrate the "vanished" side.

Typography and Lettering . . .

In the technical and scientific world, the lettering and annotations are as important as the drawing. It's important that these annotations be perfectly consistent and compatible with the text.

Instead of trying to be a technical editor yourself, take the easy way: let the repro typist prepare paste-up labels and notes along with the text. This makes editorial consistency almost automatic, and of course saves your slaving over a hot Leroy set all day.

Remember that text and illustrations are closely related and depend heavily upon each other for meaning. Notes, mathematical derivations, explanations of abbreviations, etc., should be used on illustrations only when absolutely necessary. Even though a particular note or explanation has a technical bearing on the subject, it probably has already appeared in the text or should be dealt with in the caption.

Most book-face typewriter styles can stand reduction to about 50% without becoming illegible. This means you can use typewriter type on illustrations that are to be reproduced larger than 1/2 original size.

While most drawings can be lettered with the typewriter, there's always the exception. In this case, back to the lettering set--but remember to be consistent.

If Greek and math symbols are all Greek to you, grab a style manual and a stick-on type catalog. Use these research tools in learning the formation of all odd-ball forms. Handwritten symbols are often quite different from their typographical counterparts--for example:

Character	Handwritten	Typeset
alpha		α
beta		β
rho		ρ
sigma		σ

Photographs . . .

You probably won't get to direct the shooting of photographs, but let's hope you can help pick the ones used for publication. Some pointers:

- Don't use second-generation photos. (Halftones cut from other publications, no matter how good, should not be used.)

- It's best to select prints that are somewhat oversize and ask the printer to make reductions.

- Crop the photo for emphasis and composition.

- Use a sharp-pointed knife to silhouette (cut-out) photos.

- You may annotate directly on the face of the print. Use stick-up arrows for leader lines and stick-up or typewriter composition for key numbers. (You will obscure less of the face of the photograph if you use key numbers rather than fully-labelled annotations. Changes are easier, too.)

- Don't let anyone con you into painting signs to be used in photos as captions. Lettering on negatives is futile, too. Save work--put it in the typewritten caption.

- Select the photos most pleasing to the eye. These always reproduce better.

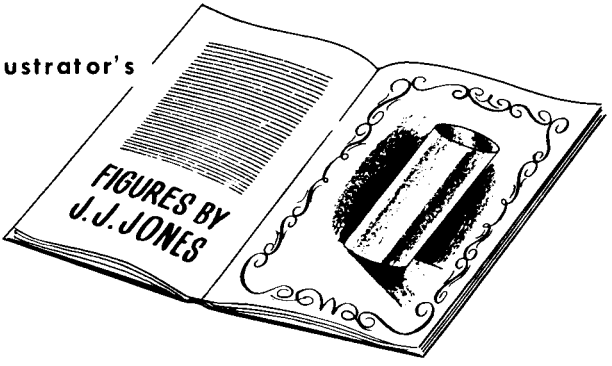
- Don't plan for color printing without consulting NASA (Code ATSP-S, Washington, D.C.).

- Color prints may be used as black-and-white illustrations, but they don't usually come out as well as do black-and-white prints.

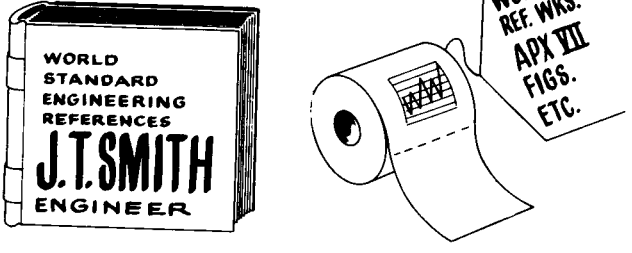
- We all like people, but portraits, candid shots, and poses have no place in a technical report. Avoid posing an engineer (even female) by a hardware item to show scale. Hands pointing to some item, feature, or failure should not be shown.

There are at least three approaches to figure layout:

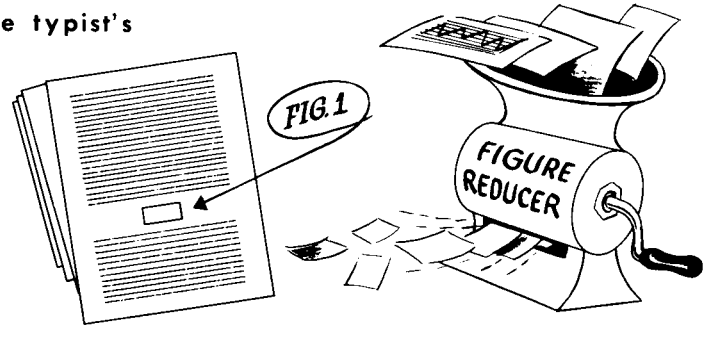
1 The Illustrator's



2 The writer's



3 The typist's



Layouts . . .

The one thing illustrator, writer, and typist have in common is that none of them is the reader. Generally, the reader suffers in silence. But even he knows that any publication is (or should be) organized for his convenience, not someone else's.

The poor forgotten reader wants to see illustrations and tables in the same page opening where he reads about them. He wants the text and illustrations so carefully inter-related and inter-woven that he can look from text to illustration and back without mentally shifting gears.

Actual layout is usually the typist's problem, but she cannot do it without information and help from the illustrator. Here are some ways you can help:

- Plan figure sizes to fit easily in the layout sheet roughly in 1/3, 1/2, and full-page sizes.

- Be flexible--plan ideal figure sizes, but prepare to make small changes to accommodate improved or changed layout.

- Be available to give advice on layout and arrangement when needed.

Remember that illustrations are a necessary part of the report, not an afterthought or attachment. The page on which the illustration appears is prepared by the typist at the same time the rest of the report is typed. This holds true for all illustrations, including full-page illustrations, photographs, foldouts, or whatever. The typist enters a page number, figure number, and a caption, each in its proper place on the layout sheet.

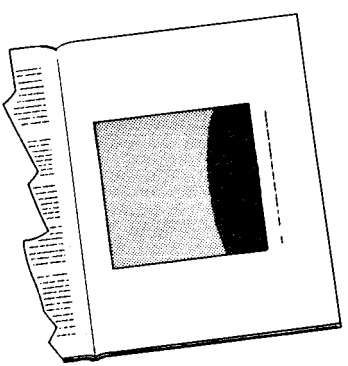
Same-size drawings may be pasted-up directly on the layout sheet above the proper caption. Oversize illustrations, however,

should be scaled for reduction. (See p. 23.) Photographs or halftone copy should not be pasted up, even if they are the proper size. They are photographed by the printer using a special process not compatible with line drawings and text.

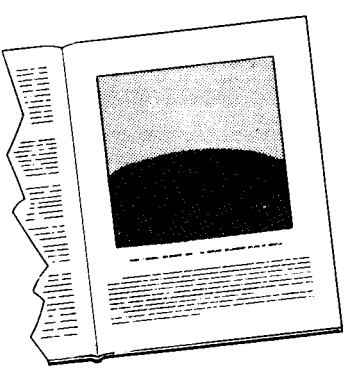
Since your reader ordinarily reads left-to-right, top-to-bottom, it makes good sense to present the illustrations in the same fashion. It's even worth some extra effort to revise an illustration so that it can be placed right-side-up on the page rather than being turned sideways.

There's always an exception that proves the rule, but after some practice, you'll find these increasingly rare.

Let's look at a specific example:



Sideways



Right-side-up

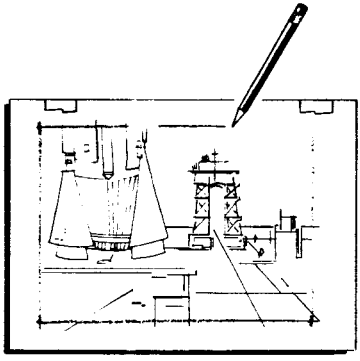
This square illustration, when turned sideways on the page must be reduced a little extra in order to make room for the caption. If turned right-side-up, the illustration can be made a little larger. A few extra typed lines, 15 or 16 of them, can usually be run on a page with a square illustration.

Figuring Reductions . . .

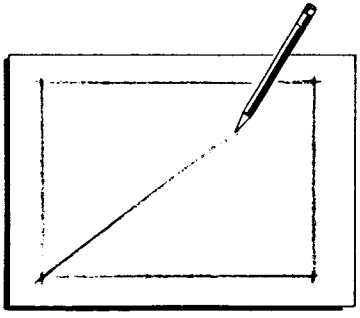
Any oversize copy (tables, photographs, graphs, drawings, etc.) may be reduced to a smaller size, provided the smaller size is proportional to the original.

It's really not difficult to find proportional sizes if you follow the rules. If you're not good at math, but have a ruler and T-square, try this easy way:

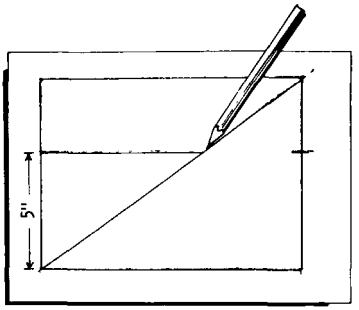
We have a 9 x 12-inch drawing, but want to fit it in the text so that it is no more than 5 inches high--then how wide would it be?



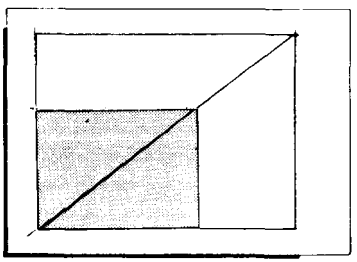
FIRST: Put a piece of onionskin over the face of the drawing and with a ruler lightly draw a line around the part of the drawing you want to reproduce.



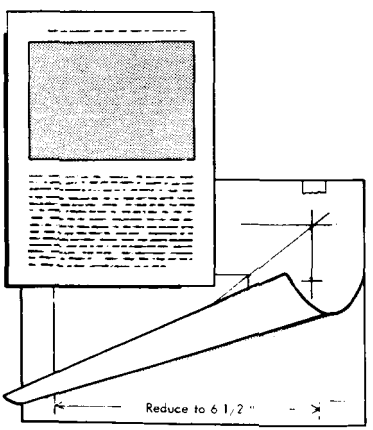
SECOND: Remove the onionskin from the drawing and draw a diagonal across the ruled-in rectangle.



THIRD: Measure 5 inches on each of the vertical sides of the rectangle and make a mark. Connect the marks.



FOURTH: Complete the new, smaller rectangle (shaded area). This then is a rectangle proportional to the original and 5 inches high. Measure the width.



LAST: Trace the small rectangle on your repro page in the exact space where it should appear. Indicate the final reduced width on the wide dimension on the drawing, along with the figure number and page number. Attach the onionskin to the face of the drawing for protection.

But reducing figures isn't just a handy dodge to help you stay out of layout trouble. Reduction can have a lot of impact on the reader--for instance, suppose he compares curves from a badly shrunk graph with another that goes full size? His reaction would show what a vital link you are in the technical information business.

Now size up some handy hints for being really indispensible:

- Graphs displaying similar, related, or comparable data should be presented in comparable sizes, with comparable scales, and in a comparable style.

- It's usually worth your time to plan (with the repro typist) the most useful layout of comparable illustrations, always considering the ultimate consumer--the reader.

- Photographic reduction isn't the only way to shrink an illustration. When an illustration is composed of several elements on a sheet, or even a single item within a border, you can make a reduction simply by taking out white space or cropping more closely. This is good practice even when drastic reduction is not called for.

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